INT J COMPUT COMMUN, ISSN 1841-9836
8(2):304-311, April, 2013.

Bio-Eco-Analysis for Risk Factors using GIS Software

R. Serbu, S. Borza, B. Marza

Razvan Serbu, Borza Sorin
Bogdan Marza
Lucian Blaga University of Sibiu
10, Victoriei Bd., Sibiu, 550024, România
E-mail: razvan.serbu@ulbsibiu.ro,
borza.sorin@ulbsibiu.ro,
bogdan.marza@ulbsibiu.ro

Abstract:
Agriculture is a business sector ideally suited for the application of Geographic Information Systems (GIS) because it is natural resource based, requires the movement, distribution, and/or utilization of large quantities of products, goods, and services, and is increasingly required to record details of its business operations from the field to the marketplace. Nearly all agricultural data has some form of spatial component, and a GIS allows you to visualize information that might otherwise be difficult to interpret. Environment has a major impact on agriculture. In this paper we presented how GIS software can be used to analyze risk factors that influence agricultural production naturally. Natural risk factors were taken into account are: land degradation, flooding, humidity, action on farmland of the wildlife. The conclusions drawn from this paper using GIS allows the adoption of important measures on a short or long time to reduce natural risk factors on agricultural production. The advantage of this model is possibility to bee extended to national, regional and global area.
Keywords: Geographic Information Systems (G.I.S.), query, Information and Communication Technologies (ICT), spatial analysis.

1 Introduction

From several existing studies that debate relationship between environmental sustainability, economic performance and competitiveness has been debated strongly for many years and still remains unclear. We have to bring to attention the Dr Javier Carrillo-Hermosilla's book named "Eco-innovation". Here are the two main views that the literature [1], [2], [3], [4] gives us of the link between environmental and economic performance, which give rise to rather different perspectives on this relationship. They are:

1. The 'traditionalist', or neoclassical, view of a trade-off between environmental performance and competitiveness. According to this view, the purpose of environmental regulation is to maximize social welfare, making polluting firms responsible for the costs of the negative externality they produce, thereby correcting the market failure. As a consequence, environmental policies may have an adverse impact on competitiveness, insofar as this regulation imposes additional costs to firms. This burden may be of particular concern in industries with substantial environmental impact, where the share of environmental costs in total production costs is considerably higher than for the manufacturing sector on average. [5] A defensive business strategy and the adoption of end-of-pipe technologies may be expected. [6]

2. The 'revisionist' view adopts a more dynamic perspective of the relationship between sustainability and competitiveness, and assigns a central role to technological change and innovation. Better environmental performance can lead to lower production costs and enhance competitiveness through efficiency, productivity and new market opportunities. [7], [8], [9], [10], [11], [12] According to the so-called 'Porter Hypothesis', [13] stringent environmental regulation could

force polluting firms to seek innovations to reduce the cost of compliance and production, improving the firm's competitiveness and leading to a positive relationship between environmental and economic performance. Additionally, companies can obtain 'first mover advantages' by marketing the innovation itself and through the creation of new markets or market segments. [14] Hence properly designed environmental policies may help firms discover their inefficiencies and sources of comparative advantage, promoting innovation and creative thinking. [15] Setting aside these theoretical discussions, and in more practical terms, it is clear that technological development and institutional considerations play an important role in the transition of the economic system towards sustainability. [16] In other words, technological change is probably a necessary, albeit insufficient, condition for achieving sustainability. Institutional changes, including changes in routines, social norms, formal regulations, etc., are needed not only to induce the required technological changes, but also to encourage behavioral changes at all levels of society in more sustainable directions.

Today's major environmental problems, such as climate change, the destruction of the ozone layer, loss of biodiversity, the degeneration and erosion of soil and water pollution are characterized by their delocalization, considerable uncertainty, irreversibility and extreme complexity in terms of consequences and the likelihood that they will occur. [17]

2 The analize of Environmental Risk in Agriculture with GIS aplications

The analyze of Environmental Risk in Agriculture with GIS applications needs a multidisciplinary approach, with input and expertise required from many fields - civil and chemical engineering, physics, life sciences, ecology, geology, hydrology and statistics being some of them. A wide range of simple to complex, spatial as well as non-spatial, and quantitative as well as qualitative, input data sets is used in environmental risk assessment and analysis process. The analyze of environmental risk in agriculture process involves preparation and use of the processed information derived and presented in various ways - for example, comparative (or relative) risk analysis, cost-benefit analysis, scenario analysis, probabilistic analysis, decision matrix, sensitivity analysis etc. Due the need for using and analyzing a huge volume of the spatial as well as non-spatial environmental hazards and exposure data in a fast and reasonably accurate way, GIS based software applications using a variety of modeling techniques serve as powerful tools for effective environmental risk assessment and management. [18]

Such applications can be used for a diverse environmental risk assessment and analysis purposes. These applications can ranges from development of databases/inventory systems for simple to complex GIS layers overlays, to complex spatial decision-making systems for study of the impact of air, water and soil pollution, ecological imbalance, and natural disasters on the natural and man-made environment, including living beings, properties, infrastructure, vegetation and ecology. These systems could also be interlinked with other related systems, providing online and real-time input data feeds or communication systems, to allow continuous monitoring and tracking of environmental risks in an integrated way. Normally, it is good to start with a prototype application first, which could be expanded further based on the budgetary allocation, user needs and the user feedback obtained from the prototype's implementation.

Such a system would allow the users to develop possible scenarios using GIS and graphical icons For example, a symbol of a polluting industry planned can be placed at a user defined locations on a given regional map, showing the terrain, rivers, soil, vegetation, population, employment, infrastructure, land-use and wild life attributes, and to evaluate the different aspects of the environmental risk, for a set of industry locations scenarios.

It can help in developing a prior understanding of the potential risks and for arriving at the best possible alternatives, within the given constraints. There actions could be a combination of human actions taking place in that region; for example, establishment of an agricultural zone, clearing of some forest area to obtain news terrains for agriculture. This entire situation involves a complex set of multiple actions over a wide geographic region, so there would a need for the system to be able to analyze & manage the environmental risks posed by the combination of these actions.

F. Capra states that by developing and using some systemic biology, each organic part of the common live is an integral whole and therefore a lively system regardless if we refer to individual systems or social ones, to ecosystems we coexist with and we develop.

The economy as live organism is a system composed by human beings and social ones interacting with one another and the ecosystems that are around us and our life depend on.

It is from the perspective of the systemic vision that it comes out the understanding the problems with interrelationships that are coming up at the level of the whole common live economy is part of.

To look at the economic life apart from the environment, from people's life, families and communities, from the life of the organizations and institutions means to fail understanding that economy is a live (vivid) system in a continuous change and evolution, dependent on the change of the ecologic and social systems it finds it self related. It is from understanding the economy as a live (vivid) organism that a radical change results in the way the processes of economic growth and development are being conceived, mechanisms backed by the institutions that govern and manage the crisis. This change resulted by the essence of systemic wisdom has the origin in understanding the wisdom of nature and is the substance of the ecologic consciousness Bateson talked about, the fact that our natural environment is not only live but conscious too.

A new economy as a live vivid organism entails a powerful investing in human resources, developing the human wisdom in such a way as to enforce a new directing of science and technology towards the organic, in a gentle, non violent, elegant way.

3 Spatial analysis of natural and hazards factors of risk in agriculture using Geomedia Professional Software

The risk analysis of natural and hazard factors, we started with some definitions [19]:

Hazard is "a threatening event or the likelihood in a region in a given period of a natural phenomenon potentially harmful (damage, environmental damage, human casualties)

Risk is defined as "the potential number of casualties, injuries, property damage of any kind, produced during a reference period in a given region, where there is a particular natural phenomenon".

Natural disaster is "a serious disruption of functioning of a society, causing loss of life, materials and environment, which the company can not exceed in-house".

The vulnerability is "the degree of loss (0-100%), a phenomenon resulting from potentiality to produce casualties and material damage", depending on the vulnerability of socio-economic development of the area concerned.

In addition to the above definitions, there are many approaches that are intended to complement and enhance the significance of the terms set [20].

Analysis of risk factors in Sibiu County was based on a map using GIS software, Geomedia Professional. We obtain the map with major risk factors [21].

The Areas where they occur are presented in map:

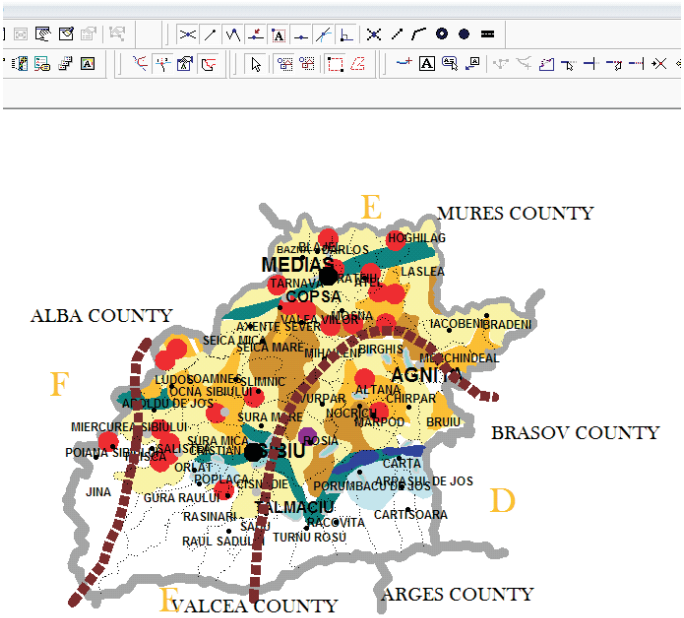

Figure 1: The map with major risk factors.

• Relatively stable areas with different risk of flooding and embankment works without clogging and regulate rivers and streams of water and maintenance of beds;

• Stable areas but with the risk of water stagnation, due to low permeability of soil;

• Risk areas due to excessive soil moisture by raising the groundwater or irrigation;

• Moderate to strong erosion areas with high risk of landslides activation when heavy rain, deforestation or work on slopes;

• Strong unstable areas affected by erosion, excessive, coupled with active gulling and landslides, torrents, and springs coastal;

• Unstable areas at high risk of landslides, collapses and collapsing;

• Seismic zone, (MSK scale);

• Area of seismic risk as normative P100-1992 (F=0,008;E=0,12;D=0,16)

• Areas affected by landslides;

• Areas affected by floods due to overflowing rivers;

• Areas affected by floods due to leakage from the slopes.

The legend shown in the figure above, appears in Figure 2.

All these risk areas are represented in the map made. GIS product provides great opportunities for spatial analysis [22]. You can see the weight of each risk factor in the whole county.

The analysis of the digital map shows that:

• High risk factor for landslides is relatively high in Sibiu county, this having a negative influence on agriculture and human habitat;

• Soil erosion with negative influences on agriculture is another important factor which covers a large area in the county of Sibiu;

• Flood risk is important in the county. On the map are located in areas where floods occurred with disastrous effects. In Sibiu floods occurred in the years: 1956, 1958, 1960, 1962, 1965, 1967, 1969, 1970, 1971, 1975, 1982, 1985, 1998, 2005;

• In general the county is a hilly area, the beds of watercourses characterized by gently sloping broad flood plain areas, without equipped with storage or flood defense and without extraction

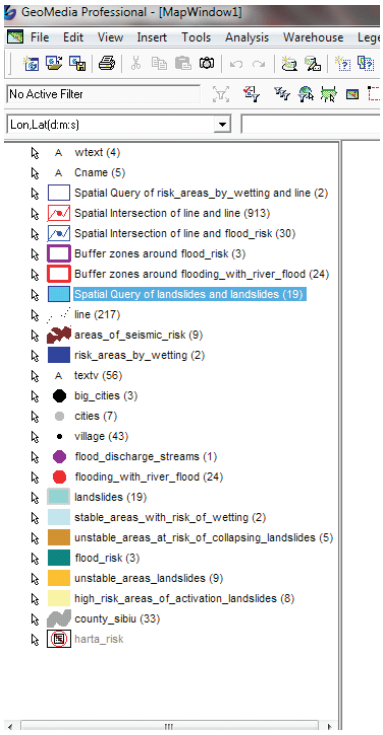

Figure 2: The legend of the major risk factors map.

opportunity ballast;

• The analysis of the map also notes the significant share that has seismic risk factor in Sibiu County.

GIS software allows obtaining custom information using spatial analysis and the particular attribute and spatial queries [23]. So you can analyze the influence of risk on a certain area, using buffer zones. For example in the figure below we present a buffer area for flood risk factor.

In the map made, we may introduce new risk factor such as, referring to the influence of wildlife on agricultural production. Although the number of wild animals in Sibiu County decreased by about 50% in last years, it continues to represent a significant risk on agricultural production, in rural areas

Given the issues outlined above, Figure 4 presents a map that allows the analysis of other natural factors of risk. The map has 3D features.

4 Conclusions and Future Works

Spatial analysis is very importance to all areas and in agriculture also. The spatial analysis can determine the relevant institutions to take certain measures to be taken as:

- Make works of dams and abundant vegetation cleaning;
- Reforestation areas with landslides;
- Cant dams;
- Repair of retaining walls;
- Desalting of water courses;
- Desalting of culverts sections.

Motivations of people who live within rural areas, to adopt and use information technologies and those of communication, can differ from the reasons people have within the urban environ-

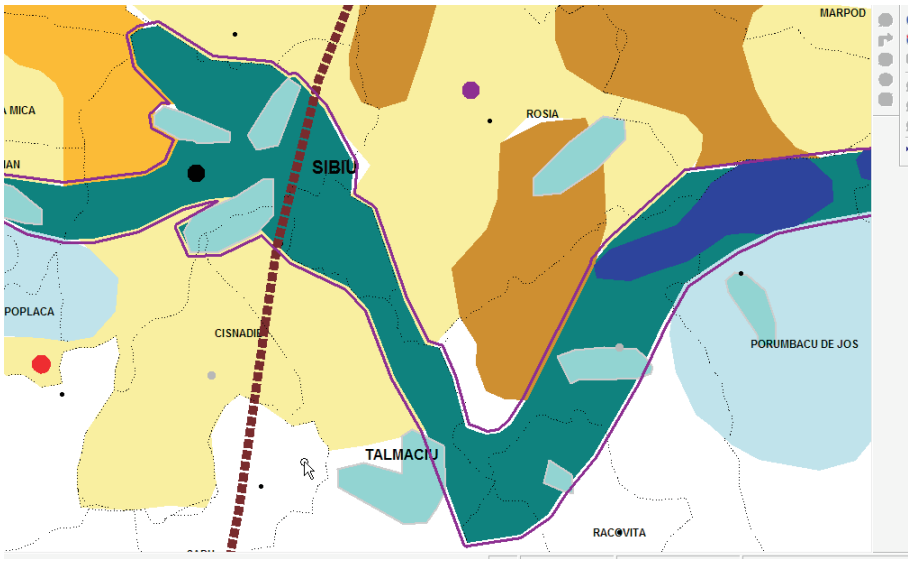

Figure 3: The 3D map of risk factors in the Talmaciu area.

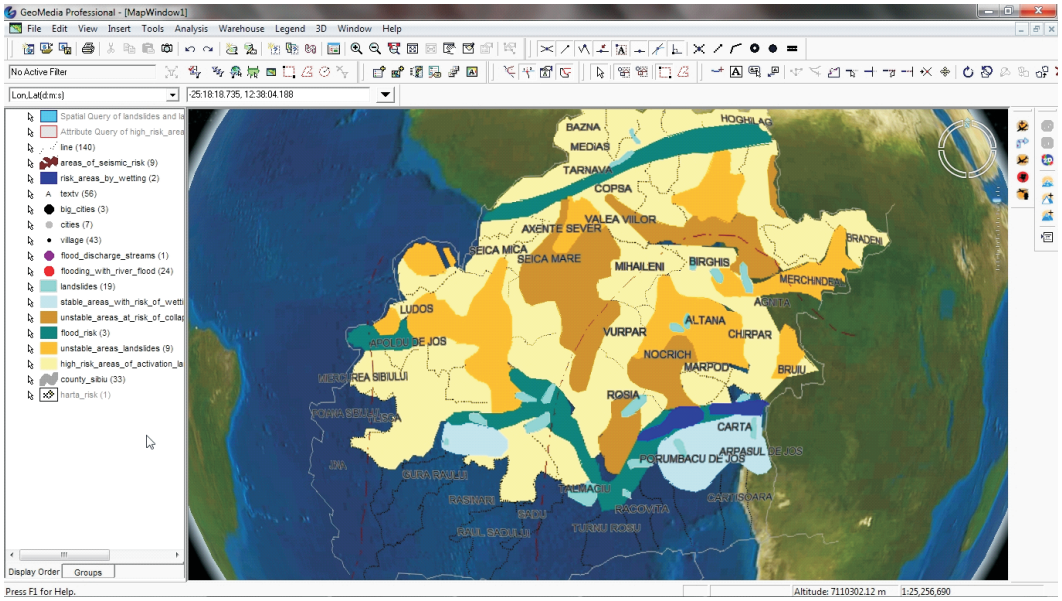

Figure 4: The 3D map of risk factors in the Sibiu county area .

ment. Regarding the implications of Geographic Information Systems in bio-economic analyses of some natural factor of risk, the people from rural area should be more interested because now they can minimize the gap between rural and urban development.

Researches suggest that information and communication technologies (ICT) can eliminate the handicap of distance concerning distance and social interaction. Donald Janelle used the expression "convergence time-space at the end of year '60 in order to describe the capacity of transport, of technologies, in order to approach different places" [18]. The risk we discus about, are between the one that minimize the profit and the good living of people living in the rural area. These people can take advantage of these technologies, and information and communication technologies (ICT) offer this way entirely.

Using information and communication technologies might have greater impact on some persons within the rural area, than another one who lives in the urban environment, because a person who lives in rural area can now access information, goods and services and very important, information that they couldn't before.

Now when the global crisis is being considered as a complex, multi dimensional one with faces that reach each aspect of our life - health and living conditions, quality of the environment and social, economic, technological, political relationships... a crisis of intellectual, moral, spiritual dimensions , a vast crisis as there has not been before in humanity, human re- spirituality as sustainable ground of that of the institutions representing a redefining of the human nature from the perspective of the fact the revolution of the means must be subordinated permanently to expectations , only out of their harmony results the health of the entire common live formed of people, communities, organizations, families and institutions.

Acknowledgements

This paper was co-financed from the European Social Fund through Sectoral Operational Programme Human Resources Development 2007 - 2013, project number POSDRU /89/1.5/S/63258 "*Postdoctoral school for zootechnical biodiversity and food biotehnology based on the eco-economy and the bio-economy required by eco-san-genesys.*"

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